A

LAW OFFICES
BARRY R. LIPSITZ
BRADFORD GREEN
755 MAIN STREET
MONROE, CONNECTICUT 06468

PATENTS, TRADEMARKS, COPYRIGHTS

BARRY R. LIPSITZ
RALPH F. HOPPIN

TELEPHONE (203) 459-0200
FACSIMILE (203) 459-0201

BOX PATENT APPLICATION
Assistant Commissioner for Patents
Washington, D.C. 20231
Dear Sir:

Transmitted herewith for filing is the patent application of:

Inventor(s): **Chris HEEGARD, et al.**
Title: **PACKET BINARY CONVOLUTIONAL CODES**

Enclosed are:
[X] Express Mail Certificate (No. EL 263 988 586 US)
[X] Small Entity Declaration
[ ] Preliminary Amendment
[X] Patent Application Specification, including Abstract and Claims -- 28 pages
[X] Four (4) Sheets of Formal Drawings, together with separate transmittal letter
[X] Declaration and Power of Attorney Form
[X] Assignment Document (with $40.00 recordal fee) and separate Transmittal Form PTO-1595
[ ] Certified Copy of Priority Document, together with separate transmittal letter
[ ] Information Disclosure Statement, together with PTO Form 1449 and copies of cited references

Basic Fee								$380.00
Multiple Dependent Claims ($130.00)								
Foreign Language Surcharge ($130.00)								
	FOR	**NO. FILED**	-	**NO. EXTRA**		**RATE**		
EXTRA CLAIMS:	Total Claims	20	20	0	x	$9.00	=	
	Independent Claims	4	3	1	x	$39.00	=	39.00
							TOTAL FILING FEE	**$419.00**

[X] A check in the amount of $459.00 to cover the [X] filing fee and/or [X] Assignment recordal fee is enclosed.

[X] The Commissioner is hereby authorized to charge any deficiency in the payment of the required fee(s) or credit any overpayment to Deposit Account No. 50-0625.

[X] **This application claims the benefit of U.S. provisional application no. 60/098,089 filed August 27, 1998.**

Respectfully submitted,

Barry R. Lipsitz
Attorney for Applicant(s)
Registration No. 28,637

Attorney Docket No.: ALA-101
Date: August 4, 1999

Applicant or Patentee: **Chris HEEGARD and Matthew B. SHOEMAKE**
Application or Patent No.:
Filed or Issued: **Herewith**
For: **PACKET BINARY CONVOLUTIONAL CODES**

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 C.F.R. 1.9(f) and 1.27(c)) SMALL BUSINESS CONCERN

I hereby declare that I am
[ ] the owner of the small business concern identified below:
[X] an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN: **ALANTRO COMMUNICATIONS, INC.**
ADDRESS OF CONCERN: **141 Stony Circle, Suite 210**
Santa Rosa, California 95401

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 C.F.R. 121.3-18, and reproduced in 37 C.F.R. 1.9(d), for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled: **PACKET BINARY CONVOLUTIONAL CODES** by inventor(s) **Chris HEEGARD and Matthew B. SHOEMAKE** described in **[X]** the specification filed herewith; [ ] application no. _________ filed _____________ [ ] patent no. _________ issued _______________.

If the rights held by the above identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below* and no rights to the invention are held by any person, other than the inventor, who could not qualify as a small business concern under 37 C.F.R. 1.9(d) or by any concern which would not qualify as a small business concern under 37 C.F.R. 1.9(d) or a nonprofit organization under 37 C.F.R. 1.9(e).

*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 C.F.R. 1.27)

FULL NAME____

ADDRESS____
[ ] individual [ ] small business concern [ ] nonprofit organization

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 C.F.R. 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON IGNING: **Eric Rossin**
TITLE OF PERSON OTHER THAN OWNER: **President**
ADDRESS OF PERSON SIGNING: **141 Stony Circle, Suite 210, Santa Rosa, California 95401**

SIGNATURE X ____________________

DATE X July 30, 1999

PACKET BINARY CONVOLUTIONAL CODES

This application claims the benefit of U.S. provisional application no. 60/098,089 filed on August 27, 1998.

FIELD OF THE INVENTION

The present invention relates to convolutional coding for data communications, and more particularly to a convolutional code that is scrambled by a pseudo-random (PN) sequence to rotate selected, transmitted symbols by 90 degrees.

BACKGROUND OF THE INVENTION

Current network communications systems generally utilize a layered, packet-based approach for transmitting data, although a non-packet based (i.e., continuous) data format may also be used. In such networks, the purpose of each layer is to offer particular services to the higher layers. Each layer

is shielded from the details of how the services are actually implemented. The lowest layer is the physical layer (PHY), which is concerned with transmitting raw bits over a communication channel. The goal of the physical layer is to make sure that when the transmitted bit is a "1", it is decoded by the receiver as a "1" and not as a "0", and vice-versa.

One technique for communicating data over the physical layer is known as trellis coded modulation (TCM). TCM is a combined Forward Error Correction (FEC) coding and modulation scheme that utilizes an underlying convolutional code applied to certain bits of M-ary Phase Shift Keyed (MPSK) or M-ary Quadrature Amplitude Modulation (MQAM) symbol mappings. The utility of TCM is in providing an increased data rate over bandlimited channels using straightforward decoding hardware. See, e.g., Viterbi, Andrew et. al., "A Pragmatic Approach to Trellis-Coded

Modulation," *IEEE Communications Magazine*, July 1989, pp. 11-19.

Currently, various convolutional codes are under discussion for use in a high-speed PHY that operates, e.g., at a carrier frequency of 2.4. GHz. It would be advantageous to introduce such a code that produces improved performance in terms of signal to noise ratio (SNR) and multi-path rejection. The provision of such a code would advantageously allow the high-speed PHY to be used in a greater range of applications than would be possible with previously proposed techniques, such as complementary code key (CCK) modulation.

It would be further advantageous to provide a binary convolutional code that generates sufficient gain to enable improved range, improved throughput, and reduced transmission delay. Moreover, an encoder for such a code should have low computational complexity. Still further, it would be advantageous if the mechanism for using such a code would be similar

to the multi-rate mechanism already provided for supporting optional rates set forth in the IEEE 802.11b wireless local area network standard.

The present invention provides a binary convolutional code having the aforementioned and other advantages.

SUMMARY OF THE INVENTION

In accordance with the present invention, a method is provided for convolutionally encoding digital data for transmission over a communication channel. In a first embodiment, the data are processed using a 64-state, rate ½ binary convolutional code based on octal generators 133, 175 to provide binary convolutional coded codewords. The codewords may be scrambled prior to transmission over the communication channel.

In a preferred embodiment, the codewords are encoded jointly onto in-phase (I) and quadrature (Q) channels. The codeword bits are mapped to a constellation according to a binary pseudo-random scramble sequence (also referred to as a cover sequence). In the event that a bit of the scramble sequence corresponding to a particular codeword bit has a binary value of, e.g., zero, the constellation is maintained in a current relationship with respect to the constellation axes. In the event that the

corresponding bit of the scramble sequence has the opposite binary value (e.g., one), the constellation is rotated by ninety degrees, e.g., in a counterclockwise direction.

The scramble sequence can be generated from a seed sequence such as the sequence 0011001110001011, where the first bit of the sequence in time is the left most bit.

Apparatus is disclosed for encoding data for use in digital communications systems. The apparatus includes a binary convolutional encoder and a scrambler for scrambling codewords provided by the encoder prior to transmission over a communication channel. In an illustrated embodiment, the scrambler is responsive to a scramble pattern generator.

In a second embodiment, the data are processed using a 64-state, rate 2/3 binary convolutional code based on octal generators $\begin{pmatrix} 21,02,12 \\ 10,25,12 \end{pmatrix}$ to provide binary convolutional coded codewords.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram of a first embodiment of a binary convolutional coding (BCC) encoder in accordance with the present invention;

Figure 2 is a block diagram of an example implementation for the BCC encoder of Figure 1;

Figure 3 is a diagram showing a possible QPSK mapping with 90° rotation in accordance with the invention;

Figure 4 is a diagram showing a possible BPSK mapping with 90° rotation in accordance with the invention;

Figure 5 is a block diagram of a second embodiment of a BCC encoder in accordance with the present invention;

Figure 6 is a block diagram of an example implementation for the BCC encoder of Figure 5; and

Figure 7 is a diagram showing a possible 8PSK mapping with 90° rotation in accordance with the invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides a method and apparatus for encoding data for use in digital communications systems. More particularly, a binary convolutional coding (BCC) scheme with a 64-state binary convolutional code and a scramble sequence is disclosed. It is noted that schemes with other codes (e.g., an N-state BCC) can also be provided in accordance with the invention. The output of the BCC is encoded jointly onto corresponding in-phase (I) and quadrature (Q) communication channels, as further documented hereinafter. This provides enhanced multi-path performance and reduced complexity in comparison to the use of two generators and independent encoding of the I and Q channels. The scramble sequence also provides added multi-path immunity.

One possible implementation of an encoder in accordance with the present invention is illustrated in Figure 1. Incoming data are first encoded in a BCC encoder 10 (e.g., a rate ½ encoder) with a binary convolutional code that is well suited for difficult channels such as wireless communications channels. An example of such a code is described in detail below, although it should be appreciated that the present invention also applies to other codes that will be apparent to those skilled in the art. The encoded data are scrambled using, e.g., a QPSK scramble map 12, before transmission through the communication channel. The QPSK scramble map is responsive to a scramble pattern generator 14, such as a pseudo-random sequence generator, for scrambling the encoded data from the encoder 10. As will be appreciated by those skilled in the art, the encoder of Figure 1 outputs two bits (QPSK) for every one bit input, thus implementing the rate 1/2.

A binary convolutional code that can be used, for example, is a 64-state, rate ½ code. The generator matrix "G" for one such code is given as

$$G=[D^6+D^4+D^3+D+1,\ \ D^6+D^5+D^4+D^3+D^2+1]$$

or in octal notation, it is given by $G=[133,\ 175]$. This code provides a good trade-off between additive white Gaussian noise (AWGN) performance and performance in multi-path environments.

The data used in this scheme may be continuous or packet based. If the invention is used in a packet-based system, then the encoder is placed in a known state at the beginning and the end of every packet. This prevents the data bits near the end of the packet from being substantially less reliable than those early on in the packet. To place the encoder in a known state at the beginning of a packet, the *M* memory elements of the convolutional encoder (e.g., the six memory elements 20 described below in connection with

Figure 2) are loaded with predetermined values that are typically all zeros. To place the encoder in a known state at the end of a packet, *M* (e.g., six) deterministic bits are input immediately following the last data bit input to the convolutional encoder. These bits are typically all zero, which places the encoder in the zero state.

A block diagram of one possible implementation of BCC rate ½ encoder 10 is shown in Figure 2. The illustrated encoder consists of six memory (i.e., delay) elements designated by reference numeral 20. For every data bit input at input terminal 22, two output bits are generated at terminals 24, 26. Modulo-2 adders 30 are connected to specific outputs of the memory element stages to implement the desired generator matrix, which in the case illustrated by Figure 2 is $G=[133,\ 175]$. Thus, as illustrated, adders 30 are provided at stages D, D^3, D^4, and D^6 to

implement G=133 and adders 30 are provided at stages D^2, D^3, D^4, D^5, and D^6 to implement G=175.

The output of the binary convolutional code is mapped to a constellation using one of two possible modes. One mode uses quadrature phase shift keying (QPSK), as shown in Figure 3, and the other uses binary phase shift keying (BPSK) as shown in Figure 4. In the QPSK mode, each pair of output bits (00, 01, 10, 11) from the binary convolutional code is used to produce one symbol, while in the BPSK mode, each pair of bits from the BCC is taken serially and used to produce two PSK symbols. This yields a throughput of one bit per symbol in QPSK mode and one-half a bit per symbol in BPSK mode.

The mapping from BCC outputs to PSK constellation points in the BPSK and QPSK modes is determined by a pseudo-random scramble sequence generated by scramble pattern generator 14 (Figure 1). If the value of the scramble sequence is equal to one, then the

constellation is rotated counter-clockwise by ninety degrees relative to the constellation that is provided for a scramble sequence value of zero. This is shown for the QPSK mode in Figure 3 and for the BPSK mode in Figure 4. More particularly, it can be seen from the figures that the constellation for S=1 is rotated by ninety degrees with respect to the corresponding constellation for S=0. It should be appreciated that other implementations can be provided where, e.g., the constellation is rotated in a clockwise direction instead of a counterclockwise direction, or in which rotations of other than 90° are used.

The pseudo-random scramble sequence is generated from a seed sequence. The seed sequence can comprise, for example, the 16-bit sequence 0011001110001011, where the first bit of the sequence in time is the left most bit. This sequence in octal notation is given as 150714, where the least significant bit is the first in time. This seed sequence is used to

generate the pseudo-random scramble sequence of length 256 bits that is used in the mapping of the current PSK symbol. It is the current binary value of this sequence at every given point in time that is taken as "S" in Figures 3 and 4.

This sequence of 256 bits is produced by taking the first sixteen bits of the sequence as the seed sequence, the second sixteen bits as the seed sequence cyclically left rotated by three, the third sixteen bits as the seed sequence cyclically left rotated by six, etc. If ci is the ith bit of the seed sequence, where 0 <= i <= 15, then the sequence that is used to scramble the data are given row-wise as follows:

c0 c1 c2 c3 c4 c5 c6 c7 c8 c9 c10 c11 c12 c13 c14 c15
c3 c4 c5 c6 c7 c8 c9 c10 c11 c12 c13 c14 c15 c0 c1 c2
c6 c7 c8 c9 c10 c11 c12 c13 c14 c15 c0 c1 c2 c3 c4 c5
...
c10 c11 c12 c13 c14 c15 c0 c1 c2 c3 c4 c5 c6 c7 c8 c9
c13 c14 c15 c0 c1 c2 c3 c4 c5 c6 c7 c8 c9 c10 c11 c12

For packet based systems with more than 256 bits and continuous systems, this sequence of 256 bits is simply repeated.

Figures 5 to 7 illustrate another embodiment in which a 256-state, rate 2/3 code is implemented. Such an embodiment can be used to provide, for example, a 22 Mbps PBCC. Referring to Figure 5, incoming data are first encoded in a rate 2/3 BCC encoder 50. The encoded data are scrambled using, e.g., an 8PSK scramble map 52, before transmission through the communication channel. The 8PSK scramble map is responsive to a scramble pattern generator 14, which can be identical to that described above in connection with the rate ½ QPSK embodiment of Figure 1. As will be appreciated by those skilled in the art, the encoder of Figure 5 outputs three bits (8PSK) for every two bits input, thus implementing the rate 2/3.

The generator matrix "G" for the rate 2/3 code can comprise:

$$G(D) = \begin{bmatrix} D^4+1 & D & D^3+D \\ D^3 & D^4+D^2+1 & D^3+D \end{bmatrix}$$

In octal notation, this matrix is defined as

$$G = \begin{pmatrix} 21,02,12 \\ 10,25,12 \end{pmatrix}.$$

A block diagram illustrating one possible implementation for the BCC rate 2/3 encoder 50 is illustrated in Figure 6. The illustrated encoder consists of separate paths for the two input bits m0 (the least significant bit) and m1 (the most significant bit). The path for m0 comprises four delay elements 60, which can simply comprise memory registers as well known in the art. The path for m1 comprises four additional delay elements 62. As indicated above, for every two bits (m0, m1) input, three bits are generated at the encoder output. The three output bits are designated x0, x1 and x2, where

x0 is the least significant bit (lsb) and x2 is the most significant bit (msb). Modulo-2 adders 64 are connected to specific outputs of the delay elements to implement the desired generator matrix which, in the case illustrated by Figure 5, is represented in octal as $G = \begin{pmatrix} 21,02,12 \\ 10,25,12 \end{pmatrix}$.

The output of the BCC is mapped to a constellation using, e.g., 8PSK. An example 8PSK constellation is shown in Figure 7. Each triplet of output bits (000, 001, 010, 011, 100, 101, 110 and 111) from the BCC is used to produce one symbol. As with the embodiments of Figures 1-4, the mapping from BCC outputs to PSK constellation points in the 8PSK mode is determined by the pseudo-random scramble sequence generated by scramble pattern generator 14. If the value of the scramble sequence is equal to one, then the constellation is rotated, e.g., counter-clockwise by ninety degrees relative to the

constellation that is provided for a scramble sequence value of zero. As shown in Figure 7, the constellation for S=1 is rotated by ninety degrees with respect to the corresponding constellation for S=0. The pseudo-random sequence can be the same as described above in connection with the embodiments of Figures 1-4.

It should now be appreciated that the present invention provides various new and unique binary convolutional coding schemes. Moreover, an inventive scheme is disclosed for scrambling the encoded data prior to transmission over a communication channel. The scrambling assures that delayed versions of the codeword will not "look" like codewords to the receiver. Instead, they will look like uncorrelated noise, which improves multi-path immunity. A PN-sequence generator can be easily implemented for use in providing the scramble sequence. It is noted that long scramble sequences will improve performance with respect to co-channel interference.

The invention further provides new BCC generator structures, which can advantageously be used with the disclosed scramble sequence. Moreover, long sequences are generated from a shorter seed sequence through cyclic shifts. The concept of scrambling by rotating the constellation (e.g., by 90°) is also unique.

Although the invention has been described in connection with various preferred embodiments, it should be appreciated that numerous modifications and adaptations may be made thereto without departing from the scope of the invention as set forth in the claims.

What is claimed is:

1. A method for convolutionally encoding digital data for transmission over a communication channel, comprising the step of:

processing said data using one of a 64-state, rate 1/2 binary convolutional code (BCC) based on octal generators 133, 175 or a 256-state, rate 2/3 BCC based on octal generators $\begin{pmatrix} 21,02,12 \\ 10,25,12 \end{pmatrix}$ to provide binary convolutional coded codewords.

2. A method in accordance with claim 1 comprising the further step of:

scrambling said codewords prior to transmission over said communication channel.

3. A method in accordance with claim 2 wherein said codewords are encoded jointly onto in-phase (I) and quadrature (Q) channels.

4. A method in accordance with claim 2 wherein:

said codewords are mapped to a constellation according to a pseudo-random scramble sequence

comprising bits having one of first and second binary values;

in the event a bit of the scramble sequence has said first binary value, maintaining said constellation in a current relationship with respect to constellation axes; and

in the event a bit of the scramble sequence has said second binary value, rotating said constellation by ninety degrees.

5. A method in accordance with claim 4, wherein said constellation is rotated counterclockwise in the event said bit of the scramble sequence has said second binary value.

6. A method in accordance with claim 5 wherein said scramble sequence is generated from a seed sequence 0011001110001011, where the first bit of the sequence in time is the left most bit.

7. Apparatus for encoding data for use in digital communications systems comprising:

a binary convolutional encoder; and

a scrambler for scrambling codewords provided by said encoder prior to transmission over a communication channel.

8. Apparatus in accordance with claim 7, wherein said scrambler is responsive to a scramble pattern generator.

9. Apparatus in accordance with claim 7 wherein said codewords are encoded jointly onto in-phase (I) and quadrature (Q) channels.

10. Apparatus in accordance with claim 7 wherein:

said codewords are mapped to a constellation according to a pseudo-random scramble sequence comprising bits having one of first and second binary values;

in the event a bit of the scramble sequence has said first binary value, maintaining said constellation in a current relationship with respect to constellation axes; and

in the event a bit of the scramble sequence has said second binary value, rotating said constellation.

11. Apparatus in accordance with claim 10, wherein said constellation is rotated counterclockwise in the event said bit of the scramble sequence has said second binary value.

12. Apparatus in accordance with claim 11, wherein said counterclockwise rotation comprises a ninety degree rotation.

13. A method for encoding data for use in digital communications systems comprising the steps of:

encoding data to be communicated over a communication channel using a binary convolutional code; and

scrambling codewords provided by said binary convolutional code prior to transmission over said communication channel.

14. A method in accordance with claim 13 comprising the further step of encoding said codewords jointly onto in-phase (I) and quadrature (Q) channels.

15. A method in accordance with claim 13 comprising the further steps of:

mapping said codewords to a constellation according to a pseudo-random scramble sequence comprising bits having one of first and second binary values;

in the event a bit of the scramble sequence has said first binary value, maintaining said constellation in a current relationship with respect to constellation axes; and

in the event a bit of the scramble sequence has said second binary value, rotating said constellation.

16. A method in accordance with claim 15, wherein said constellation is rotated counterclockwise in the event said bit of the scramble sequence has said second binary value.

17. A method in accordance with claim 16, wherein said counterclockwise rotation comprises a ninety degree rotation.

18. Apparatus for encoding data for use in digital communications systems comprising:

a binary convolutional encoder for processing said data using one of a 64-state, rate 1/2 binary convolutional code (BCC) based on octal generators 133, 175 or a 256-state, rate 2/3 BCC based on octal generators $\begin{pmatrix} 21,02,12 \\ 10,25,12 \end{pmatrix}$ to provide binary convolutional coded codewords.

19. Apparatus in accordance with claim 18 wherein:

said codewords are mapped to a constellation according to a pseudo-random scramble sequence comprising bits having one of first and second binary values;

in the event a bit of the scramble sequence has said first binary value, maintaining said

constellation in a current relationship with respect to constellation axes; and

in the event a bit of the scramble sequence has said second binary value, rotating said constellation.

20. Apparatus in accordance with claim 18 further comprising a scrambler for scrambling codewords provided by said encoder prior to transmission over a communication channel.

ABSTRACT

A 64-state binary convolutional code is disclosed for a high-speed physical layer (PHY) of a communication network. The proposed code provides improved performance in terms of signal to noise ratio (SNR) and multi-path rejection than previously known codes. The proposed system, which includes binary convolutional codes with scrambling in a packet-based system, is referred to herein as "packet binary convolutional coding" (PBCC). The substantial increase in performance that may be achieved by PBCC makes it an ideal solution for high performance forward error correction (FEC) in a high-speed PHY.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	)
	)
Chris HEEGARD, et al.	)
	)
Filed: Herewith	)
	)
For: **PACKET BINARY CONVOLUTIONAL CODES**	)

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as Express Mail (No. EL 263 988 586 US) in an envelope addressed to: BOX PATENT APPLICATION, Assistant Commissioner for Patents, Washington, D.C. 20231 on:

August 4, 1999

By: Cathy Dunne

Cathy Dunne

BOX PATENT APPLICATION
Assistant Commissioner for Patents
Washington, D.C. 20231

TRANSMITTAL OF FORMAL DRAWING(S)

Dear Sir:

Enclosed are four (4) sheets of formal drawings for filing in the above-referenced patent application.

Respectfully submitted,

Barry R. Lipsitz
Attorney for Applicant(s)
Registration No. 28,637
755 Main Street, Building No. 8
Monroe, CT 06468
(203) 459-0200

Date: August 4, 1999
ATTORNEY DOCKET NO.: ALA-101

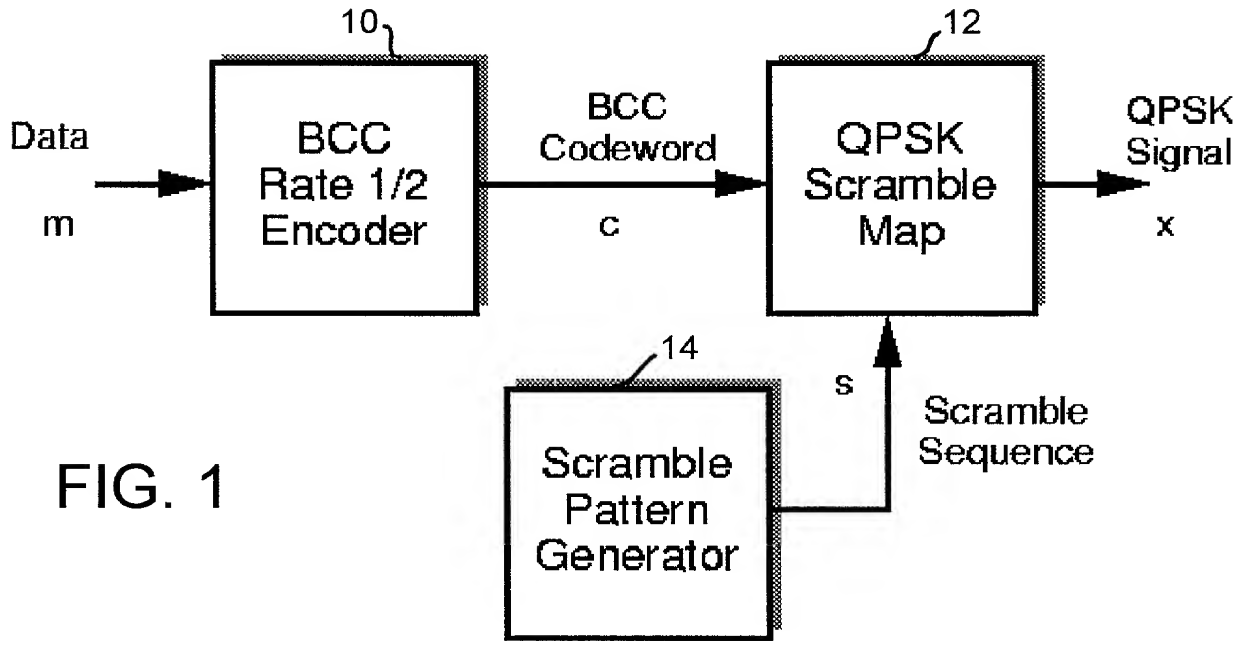

10
12
Data
m
BCC
Rate 1/2
Encoder
BCC
Codeword
c
QPSK
Scramble
Map
QPSK
Signal
x
14
s
Scramble
Sequence
Scramble
Pattern
Generator

FIG. 1

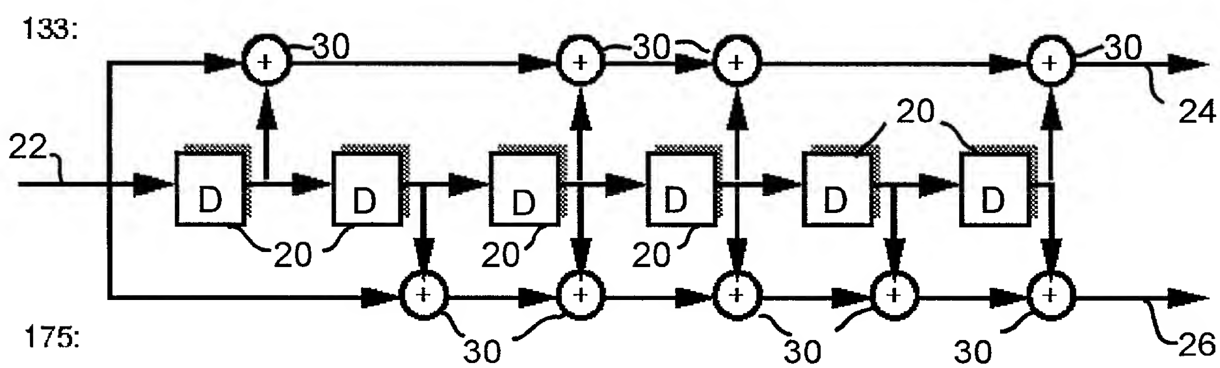

133:
175:
22
24
26
D
20
30
+

FIG. 2

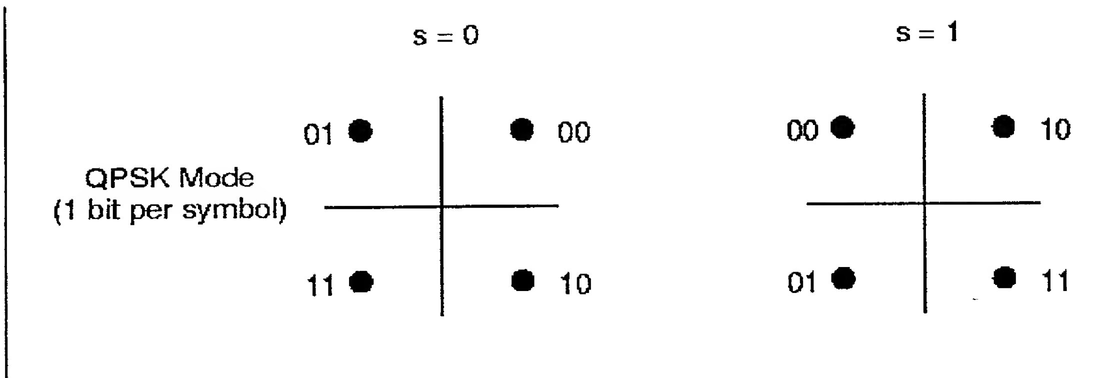

s = 0
s = 1
01
00
11
10
QPSK Mode
(1 bit per symbol)
00
10
01
11

FIG. 3

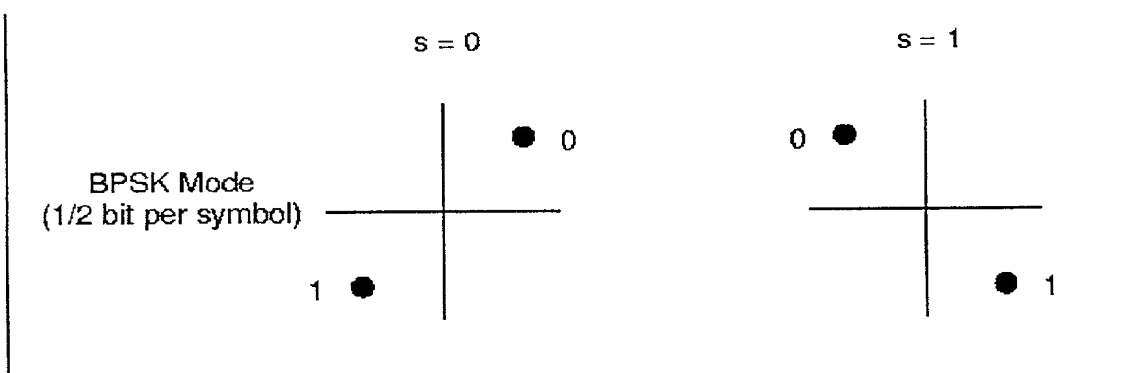
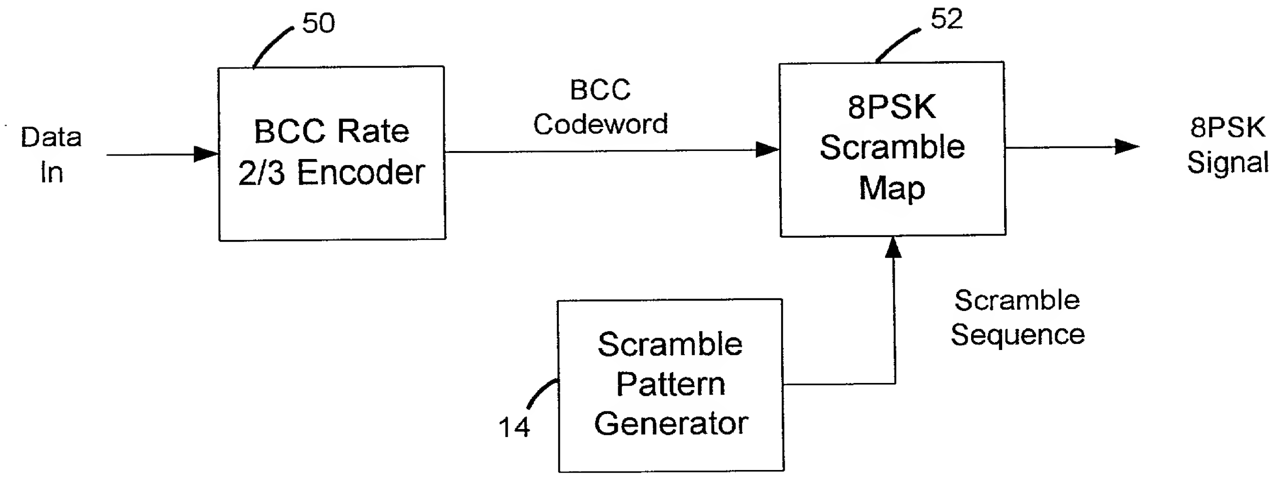
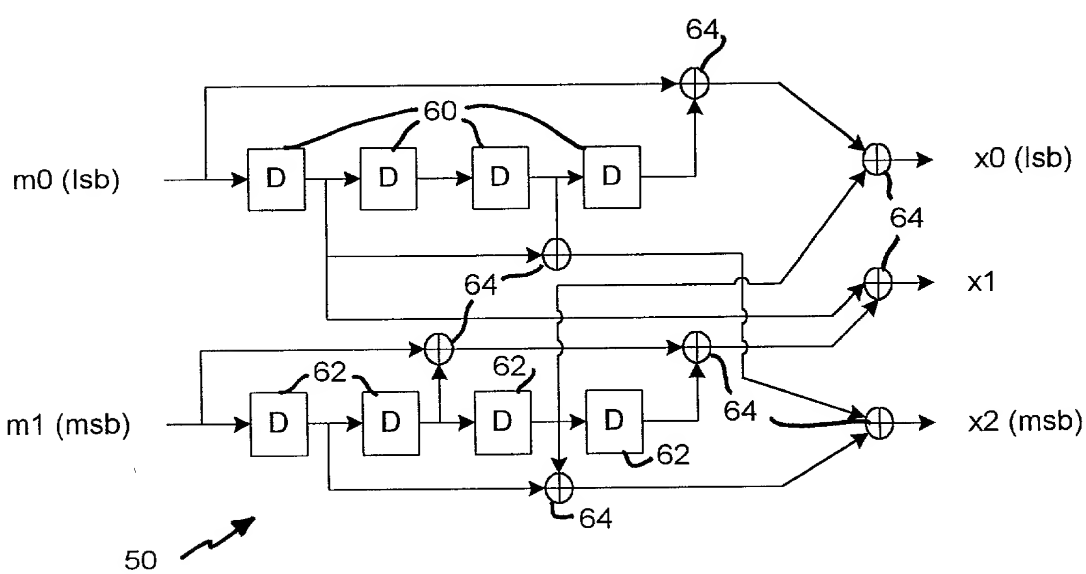

s = 0
s = 1
0
BPSK Mode
(1/2 bit per symbol)
1
0
1

FIG. 4



50
52
Data
In
BCC Rate
2/3 Encoder
BCC
Codeword
8PSK
Scramble
Map
8PSK
Signal
Scramble
Sequence
Scramble
Pattern
Generator
14

FIG. 5



64
60
m0 (lsb)
D
D
D
D
x0 (lsb)
64
64
x1
62
62
m1 (msb)
D
D
D
D
64
x2 (msb)
62
64
50

FIG. 6

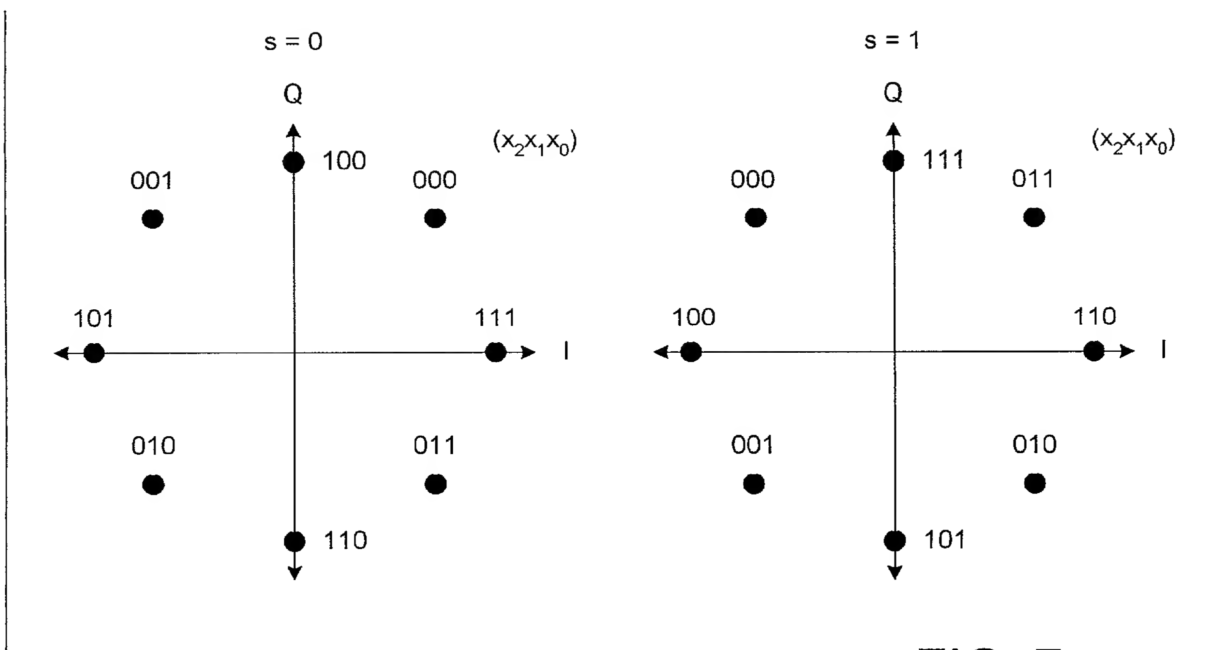

s = 0
Q
(x2x1x0)
100
001
000
101
111
I
010
011
110
s = 1
Q
(x2x1x0)
111
000
011
100
110
I
001
010
101

FIG. 7

DECLARATION, POWER OF ATTORNEY, AND PETITION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

PACKET BINARY CONVOLUTIONAL CODES

the specification of which is attached hereto unless the following box is checked:

[ ] was filed on ______________ as United States Application Number ____________ or PCT International Application Number ______________________ and was amended on ___________________ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to be material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below any foreign application for patent or inventor's certificate or of any PCT international application having a filing date before that of the application on which priority is claimed:

Priority Claimed

			[ ] [ ]
(Number)	(Country)	Month/Day/Year Filed	Yes No
			[ ] [ ]
(Number)	(Country)	Month/Day/Year Filed	Yes No

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below.

60/098,089	**August 27, 1998**
(Application Number)	(Filing Date) - Month/Day/Year

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 C.F.R. 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	**Parent Filing Date (MM/DD/YYYY)**	**Parent Patent Number (if applicable)**

And I hereby appoint: Barry R. Lipsitz, Registration No. 28,637, a member of the Bar of the State of Connecticut, and Ralph F. Hoppin, Registration No. 38,494, a member of the Bar of the State of Connecticut and State of New York, both of the firm of Barry R. Lipsitz, Attorney at Law, 755 Main Street, Building No. 8, Monroe, Connecticut 06468, Telephone (203) 459-0200, my attorney with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

Wherefore I pray that Letters Patent be granted to me for the invention or discovery described and claimed in the foregoing specification and claims, and I hereby subscribe my name to the foregoing specification and claims, declaration, power of attorney, and this petition.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor: Chris HEEGARD

Inventor's Signature X Chris Heegard Date: X 7/30/99

Residence **Santa Rosa** (City) **California** (State or Foreign Country) Citizenship: **U.S.A.**

Post Office Address **574 Laurel Circle** (Post Office Address) **Santa Rosa, California 95407** (City) (State & Zip Code/Country)

Full name of second joint inventor: Matthew B. SHOEMAKE

Inventor's Signature X Matthew B. Shoemake Date: 7/30/99

Residence **Santa Rosa** (City) **California** (State or Foreign Country) Citizenship: **U.S.A.**

Post Office Address **643 Laurel Circle** (Post Office Address) **Santa Rosa, California 95407** (City) (State & Zip Code/Country)